

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—CIRCULAR 81.

A. C. TRUE, Director.

A REPORT UPON THE DRAINAGE OF THE AGRICULTURAL LANDS OF BOLIVAR COUNTY, MISSISSIPPI.

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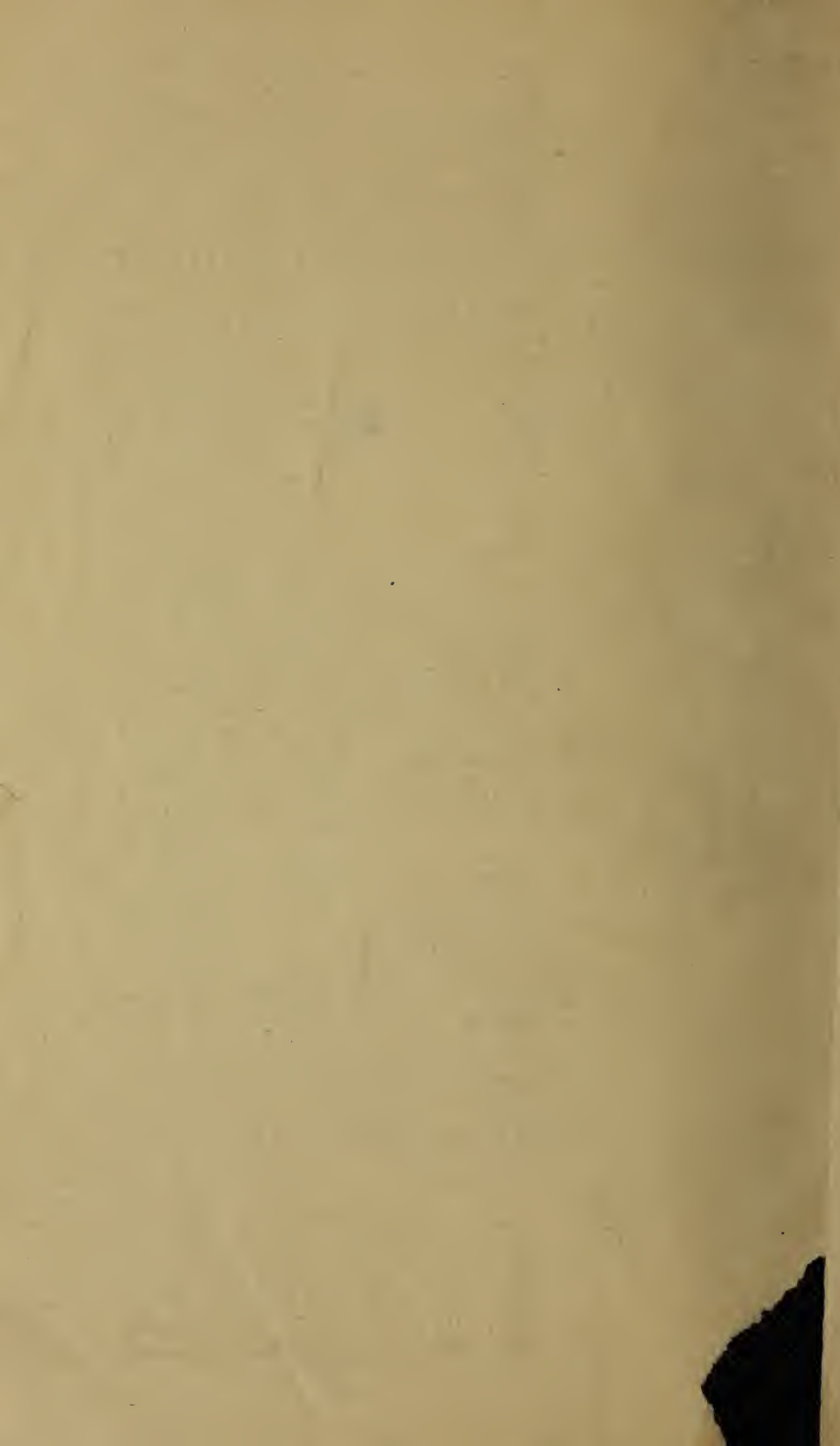
C. G. ELLIOTT,

Chief of Drainage Investigations.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., November 2, 1908.

SIR: I have the honor to transmit herewith a manuscript accompanied by a map, which gives the results of a drainage survey of agricultural lands in Bolivar County, Miss., made by Drainage Investigations of this Office during the winter 1907-8.

The investigations covered an area of 120,000 acres of fertile land in what is known as the Yazoo Delta, which is deficient in natural drainage. The report shows the physical conditions of the area with reference to its drainage, and outlines for the entire section a plan of drainage which has been developed from surveys made for the purpose; also gives an estimate of cost of the work recommended.

This report will be of great assistance to the people of that county in the development of its agriculture, and I recommend that it be printed as a circular.

Very respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

[Cir. 81]

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DRAINAGE OF THE AGRICULTURAL LANDS OF BOLIVAR COUNTY, MISSISSIPPI.

INTRODUCTION.

The wet condition of large bodies of land in Bolivar County, Miss., caused by the overflows of the banks of streams and bayous, which are insufficient to properly care for the ordinary rainfall, has been serious in the past and is gradually getting worse as the land is cleared and a larger acreage is being put under cultivation. But few attempts have ever been made to improve the natural drainage channels, as a large portion of the land is in timber and much of it owned by nonresidents. Early in the year 1907 the attention of the Drainage Investigations of the Office of Experiment Stations, United States Department of Agriculture, was called to the situation, by a request from Messrs. J. B. Lee, L. H. Gaines, William Connell, drainage commissioners, and Attorney Thomas S. Owens, J. Watt Bishop, Mr. Shelby, Isaiah Montgomery, and other local landowners, who were instrumental in having a special examination made and a plan of relief outlined. They agreed to pay a portion of the expense which would be incurred, and did so while the surveys were in progress. The district was first examined by Mr. C. G. Elliott, now Chief of Drainage Investigations, on May 22 and 23, 1907. Mr. S. H. McCrory, drainage engineer, was assigned to the work in October and began the survey under the supervision of W. J. McEathron, supervising drainage engineer. It proved to be no easy task, as quite a large portion of the district is at the present time almost a wilderness, abounding in cane thickets, open woods, and occasional clearings, and it required the full time allotted to the survey for its completion. The work closed at Shelby, Miss., February 8, 1908, and the party was disbanded at that place.

LOCATION AND AREA.

The district is situated in the Yazoo Delta in Bolivar County, Miss. The Yazoo and Mississippi Valley Railroad traverses the district from north to south and from east to west, the junction point

of the two lines being at Boyle, as shown on the general map which accompanies this report. Beginning at the intersection of Bogue Phalia with the line between townships 24 and 25, the boundary line of the district extends east on the township line to the east of Bolivar County; thence south on the county line to the southeast corner of township 23 north, range 5 west; west on the south line of this township to the Yazoo and Mississippi Valley Railroad; southerly along the railroad to the south line of Bolivar County; west along the county line to Bogue Phalia, and northerly along Bogue Phalia to the point of beginning. The greatest length of the district is $31\frac{1}{2}$ miles, its greatest width $14\frac{1}{2}$ miles, and its area 140,250 acres. Cleveland, the county seat of Bolivar County, is the largest town, and Boyle, Merigold, Shelby, Mound Bayou, Skene, and Arnold are other towns in the district.

As may be seen by referring to the map, this district is naturally divided into three parts: (1) The Bogue Hasty drainage area on the south, draining into the Bogue Phalia, and embracing an area of 46,250 acres; (2) the Snake Creek area on the north, draining 58,900 acres into the Bogue Phalia; and (3) the Big Mound Bayou area on the east, draining 30,400 acres into the Sunflower River. In addition, approximately 4,700 acres drain to the Bogue Phalia south of the Bogue Hasty district. The approximate boundaries of the drainage districts are indicated on the map.

NATURAL DRAINAGE CHANNELS AND OUTLETS.

The Bogue Phalia furnishes an outlet both for the Bogue Hasty and for Snake Creek, and in addition receives the drainage from approximately 120,000 acres of land outside the basins of these streams.

The Bogue Phalia from Napanee in Washington County, $2\frac{1}{2}$ miles below the county line, to Lee's plantation is in bad order, obstructed by trees, snags, and drifts, and in many places is too small to carry the water which comes to it. Above Lee's plantation the channel of the stream is much larger, varying in width from 125 to 175 feet, with high banks that are higher as one goes upstream, and with water from 5 to 20 feet deep. There is no apparent current, the water level being the same for 7 or 8 miles upstream. Below Lee's plantation the slope of the water surface increases. The channel is fairly straight and contains only one sharp bend. With this channel in its present obstructed condition and its insufficient carrying capacity the water in the upper parts of the river is raised during flood periods and overflows the east bank, spreading over the country east of the river, and slowly makes its way back to the Bogue Phalia through the interior drainage channels.

The Bogue Hasty, with its tributaries, drains an area of 46,250 acres in the southern part of the district. The Bogue Hasty enters the Bogue Phalia about $1\frac{3}{4}$ miles above the Washington-Bolivar County line, in sec. 30, T. 20 N., R. 6 W. About 6 miles above the point where it joins the Bogue Phalia it receives the water of Pecan Bayou from the east. About a mile above this point it forks, forming East Bogue Hasty and West Bogue Hasty. A mile above this junction East Bogue Hasty receives a tributary called Icy Bayou. All of these streams have good natural channels, but trees have grown in them, drift has accumulated in places, and there is now no yearly overflow to wash them out as there was before the Mississippi levees were completed. Consequently, the flow of water is obstructed, and they overflow their banks. All of these channels are usually dry during the summer and fall.

Snake Creek drains 58,900 acres in the northwestern part of the district, entering the Bogue Phalia in sec. 24, T. 22 N., R. 7 W. For the greater part of its course it is a series of long narrow lakes. Snake Creek begins in Holmes Lake, a narrow lake about 10 miles long, heading about 2 miles above Shelby. For the greater part of its length it is grown up with trees and brush, and there is no appreciable current excepting near the outlet. Leaving Holmes Lake, Snake Creek flows through Porter Lake, Sixmile Lake, Kimball Lake, and Alcock Lake. After leaving Alcock Lake the creek has a large channel with high banks. It has two important tributaries, Bradford Bayou and Sandy Slough.

Bradford Bayou heads in the cypress brake in sec. 36, T. 24 N., R. 6 W., and flows southwest, joining Snake Creek in sec. 27, T. 23 N., R. 6 W. It receives several small tributaries, of which Little Bradford and Dry bayous are the most important.

Sandy Slough heads in sec. 31, T. 22 N., R. 6 W., and flows north, joining Snake Creek in sec. 30, T. 22 N., R. 6 W. It has a small drainage area, but is of importance because it becomes an overflow channel from Snake Creek when the water is high.

Big Mound Bayou is the outlet for the drainage of 30,400 acres in the northeastern part of the district. It heads in the cypress brake called Barrows Lake, and flows southeast to the Sunflower River in sec. 23, T. 23 N., R. 5 W. The upper part of the bayou is narrow and shallow and in bad order. The lower part is deep and wide. It receives two large tributaries, Little Mound Bayou and Beaver Bayou.

Little Mound Bayou heads in the lowland in secs. 9 and 10, T. 24 N., R. 5 W., and flows southeast to enter Big Mound Bayou in sec. 10, T. 23 N., R. 5 W. It drains an area of 11,200 acres. It has a large channel, but is in bad order.

Beaver Bayou heads in Goose Lake, near the northeast corner of the district, and flows south to a junction with Big Mound Bayou in sec. 23, T. 23 N., R. 5 W. Part of this distance is in Sunflower County. It has a drainage area of 10,150 acres.

SURFACE CONDITIONS.

Only a small amount of land in the district is permanently swampy, although a large portion is flooded by heavy rains during the spring and early summer, due to the fact that the natural drainage channels are obstructed and filled up, and consequently are not able to remove the water quickly.

The surface of the land is very flat. The fall averages a foot to the mile in the direction of the drainage channels. The land in the district varies in elevation from 138 feet above sea level at the south line of the district to 176 feet on the bank of the Hushpuckana River at the north end of the district. All the elevations used in this report, and on the accompanying map, are referred to the Cairo datum of the Mississippi River Commission.

As shown by the map, the general slope of the district is to the south. The main line of the Yazoo and Mississippi Valley Railroad is located on the highest ground in the district, and is very nearly the dividing line between the land which slopes to the southwest and that which slopes to the southeast. Most of the district was subject to overflow by the Mississippi River before the levees were completed. The banks of the Bogue Phalia, Sunflower, and Hushpuckana rivers and Snake Creek are higher than the land back from them, and are locally called high-banked streams. As a result of this condition, the larger part of the surface drainage flows away from the rivers into the small, but well-defined interior drainage channels.

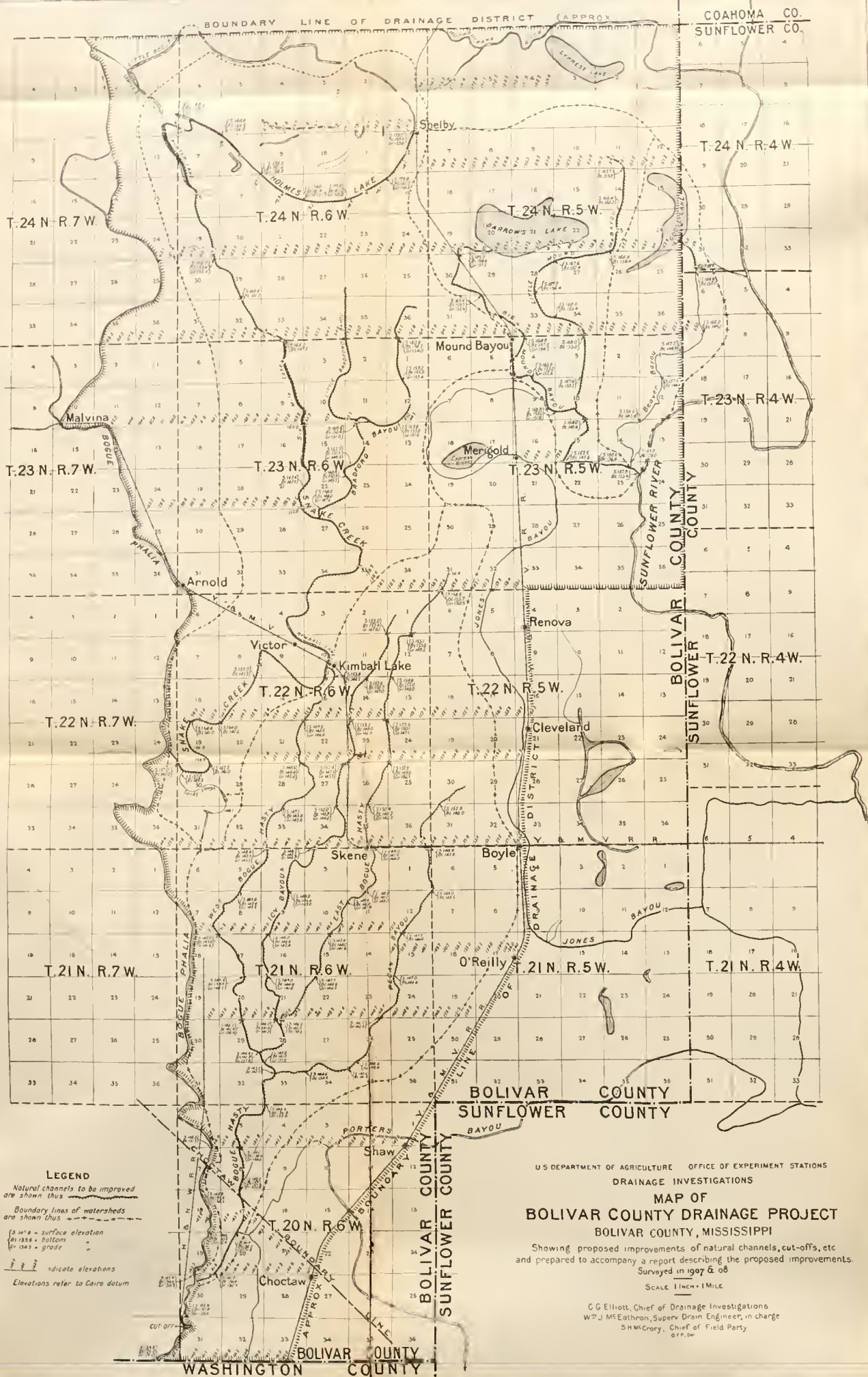
SOIL.

All the soil of the district is alluvium deposited by the Mississippi and Sunflower rivers. Three distinct types are found—a sandy loam, a loam, and a clay.

The sandy loam generally is fine and dark brown in color. It occurs in narrow bands or ridges along the rivers and streams, is well drained and permeable, permitting a free downward movement of the water. This soil is excellent for truck farming and is easy to cultivate.

The loam is dark brown or yellow and silty. The surface soil is loose and powdery when dry and only moderately sticky when wet. When moist, it appears to be very mellow and easy to cultivate. It constitutes an area lying between the sandy loam and the clay, and is not so well drained as the former.





The clay is of a drab or bluish color, and is locally termed "buck-shot." Except when very wet or very dry it crumbles or flocculates after plowing. When undisturbed by cultivation it cracks upon drying. It occupies the low-lying territory back from the streams. The surface is generally flat, and this, in connection with the close texture, results in imperfect drainage.

All the land in the district is very fertile, and was originally covered with a heavy growth of hardwood timber and an undergrowth of cane. Probably 35 per cent of the entire district is cleared.

CROPS.

Before the Mississippi River was leveed, nearly the whole district was inundated each year, and the silt deposited by the water did much to keep up the fertility of the soil and to make profitable the continuous raising of cotton. Quite a variety of crops is grown—cotton, the staple, being the only one that is exported. Corn is raised to some extent, but not enough for home consumption. Irish and sweet potatoes and vegetables of nearly all kinds grow luxuriantly, but are not raised in sufficient quantities to supply the home demand. As Bermuda grass, cowpeas, alfalfa, and some species of clover flourish, the raising of cattle and hogs would be a profitable undertaking. The length of the growing season for cotton, about seven months, makes this crop a success.

NEEDS FOR DRAINAGE.

Practically all the land in the district would be benefited by drainage in a degree, varying with the location and the character of the soil. Most of the high sandy loam needs drainage only in extremely wet years. The loam would be greatly improved by having the water removed more quickly, while the clay, because of its low, flat location and close texture, must have drainage if it is to be profitably farmed. The district lacks adequate outlets, so that under existing conditions when heavy rains occur the sloughs, bayous, and flat places fill up with water, which either finds its way slowly to the main outlets or remains until it is absorbed or evaporated. Land is cleared by throwing logs and brush in the channels as the easiest way of disposing of them, resulting in the entire or partial filling of all natural water courses.

VALUE OF THE LAND.

Land values depend on the quantity and kind of the timber on the wooded land and on its location with reference to shipping points and towns. Timber lands range in price from \$10 to \$35 per acre, and farm lands from \$15 to \$60 per acre. Rents vary from \$4 to \$8 per acre, \$6 to \$7 per acre being the ordinary rates.

DESCRIPTION OF SURVEY.

The field party for the survey of the Bolivar County drainage district was assembled October 7, 1907, under the general direction of W. J. McEathron, supervising drainage engineer. The party consisted of S. H. McCrory, chief of party; H. M. Lynde, assistant engineer, 2 rodmen, 2 axmen, 1 cook, and 1 teamster with team and wagon, and a camp outfit.

Meanders of all main bayous were necessary, as the local maps did not show their true location, and in some instances they were not shown at all, information as to the existence of a bayou generally being obtained from some resident. The Bogue Phalia was meandered from Lee's plantation, south, to the Bolivar County line. The general plan was to run a compass line in the center of the bayou, when dry, that being the only place where a survey could be made without a large amount of labor being expended in cutting the dense cane and brush. Those bayous having water in them were meandered on the bank, making progress very slow in some instances.

The stadia method was used for measuring distances, and magnetic bearing of each course was recorded. Care was taken to blaze all meandered lines plainly, trees on both sides of the line being marked by a blaze with two hacks below. A stake was set at each deflection point, and the distance from the starting point marked on it. The stakes used were generally cut from saplings about $2\frac{1}{2}$ inches in diameter and of sufficient length to be driven firmly into the ground and still have the top of the stake about 1 foot above the surface. The top and bottom widths of the bayous were recorded at frequent intervals and the locations of the bayous with reference to the compass line were carefully sketched in and located. All levels were referred to the United States permanent bench mark at Stoneville, Washington County, Miss.

All levels were checked within the allowable error for good wye level work. Elevations were taken on the lines at about 500-foot intervals and oftener when it was thought necessary. Cross sections of the channels were made as often as seemed necessary, usually at about half-mile intervals. Bench marks were set at frequent intervals along the level lines, and in addition four metallic Drainage Investigation permanent bench marks were set. A list of bench marks is given on page 28 of this report. All the natural water courses in the district were meandered except those which were found to be accurately located on existing maps.

The party completed the survey and disbanded on February 8, 1908. An area of 140,000 acres had been examined, and $146\frac{1}{2}$ miles of transit line and 329.5 miles of levels had been run.

The cost of the field survey, including supervision, was \$3,395, of which \$512 was paid by residents in the district under examination.

RAINFALL AND RUN-OFF.

From an examination of the rainfall records at Clarksdale, Miss., which lies a short distance above this district, for the years 1904, 1905, and 1906, it is found that the greatest precipitation occurs from December to May, inclusive, and ranges from a little over 1 inch to as high as 10.8 inches per month, the annual rainfall for 1904 being 39.8 inches; 1905, 61.17 inches; and 1906, 69.74 inches.

In the months of April and May is the time the greatest damage is done, as it necessitates the replanting of cotton many times. The record shows that in three years out of four the rainfall in May varied from 6.71 inches to 10.8 inches.

Usually the forty-eight-hour maximum does not exceed that of twenty-four hours, the greatest difference noted being in 1904 in December when the former was 6.47 inches and the latter 4.71 inches. The twenty-four-hour maximum generally runs from 2 to 3½ inches, anything above that being uncommon.

There is some difference of opinion as to the amount of run-off to provide for in drainage channels in this section. The fact that the upper reaches of these streams are in long narrow lakes has a tendency to keep the amount to be removed in twenty-four hours to a lower figure than if conditions were otherwise. The amount of water impounded in these lakes or reservoirs is considerable, also that held back by depressions in the lower lands back from the stream and from which the storm water does not run off as rapidly as it appears to, has a tendency to reduce the amount of water to be removed in twenty-four hours from a given area. For these reasons the twenty-four-hour run-off on the Bogue Phalia was placed at one-half inch in twenty-four hours, while the smaller ditches in bayous, not heading in lakes of any extent, were planned to provide for the removal of three-fourths inch of water from their entire drainage area in the same time, this being about double the amount provided for in the drainage of level lands in northern sections. It is believed that the channels outlined on this basis will provide for the drainage of the land thoroughly if well maintained after construction.

PLANS FOR PROPOSED IMPROVEMENTS OF BOGUE PHALIA.

It is proposed to improve the Bogue Phalia from above the drift at the Helm and Northwestern Railway bridge south to a point about one-half mile below the south line of Bolivar County. The Bogue Phalia has a drainage area of 224,000 acres above the Bolivar-Wash-

ington County line. To remove one-half inch of water from this area in twenty-four hours will require the removal of 4,700 cubic feet per second.

The channel is planned to be 100 feet wide on the bottom from a point one-half mile below the county line to the outlet of Bogue Hasty, and 80 feet wide on the bottom from this point to the Helm and Northwestern Railway bridge above Lee's plantation. Side slopes are to be 1 to 1, and the slope of the bottom of the channel will be 1.58 feet per mile throughout the entire distance. With the water 10 feet deep in the channel, the discharge of the larger channel has been computed by Elliott's formula for velocity in open channels to be 4,840 cubic feet per second. This formula gives the same results as Kutter's, giving his coefficient N the value of 0.025, giving C the value of 89.

$$V = \sqrt{\frac{A}{P}} \times 1\frac{1}{2} F.$$

$$Q = A V.$$

In which V =velocity in feet per second.

A =area of channel in square feet=1100.

F =fall in feet per mile = 1.58.

P =wetted perimeter in feet = 128.

Q =discharge in cubic feet per second.

Substituting quantities in the formula:

$$V = \sqrt{\frac{1100}{128}} \times 2.25 = 4.4.$$

$$Q = 1100 \times 4.4 = 4840.$$

$$\text{Quantity required} = 4700.$$

With the grade line as specified, the average depth of the channel will be 13 feet from Lee's plantation to the Bogue Hasty, and 15 feet from the Bogue Hasty to the lower end of the improvement.

The work should be begun by removing the drift at the Helm and Northwestern bridge. The drift in the channel on Lee's plantation should then be removed, and the excavation required to clean the channel be begun above the drift. Where the channel divides here the east part should be dammed, so that all the water will be forced to go down the present west channel. From this point the present channel of the river will be followed as nearly as possible, to secure the greatest economy of excavation. One short cut-off is planned at a point about 1 mile north of the county line. Here the

Bogue Phalia makes a loop that is about 2,200 feet around and but 300 feet across at the narrowest place. The present channel should be cleared of trees, undergrowth, and drift from where the excavation is to be stopped, one-half mile below the county line, at least to the Southern Railway bridge at Napanee, a distance of about 3 miles. At several places along the river there are overflow channels from the river out to the land on the east. The largest of these are in sec. 16, T. 21 N., R. 6 W., and at Lee's plantation in sec. 7, T. 20 N., R. 5 W. There are several smaller channels south of Lee's plantation and north of the Bogue Hasty. Probably all except the two largest may be closed by the excavated material from the Bogue Phalia and these should be closed after the Bogue Phalia improvement has been completed.

It is estimated that 613,000 cubic yards of excavation will be required to complete the improvement of the Bogue Phalia as planned. The following tabulated statement gives the approximate amount of excavation for each twenty sections:

Approximate quantities of excavation required for the improvement of Bogue Phalia.

Station.	Average cross sectional area to be excavated.	Excavation.	Station.	Average cross sectional area to be excavated.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
0-20.....	435	32,000	160-180.....	495	37,000
20-40.....	382	28,000	180-200.....	565	42,000
40-60.....	621	46,000	200-220.....	580	43,000
60-80.....	850	63,000	220-240.....	572	42,000
80-100.....	895	66,000	240-260.....	512	38,000
100-120.....	786	58,000	260-280.....	460	34,000
120-131.....	796	32,000			
131-140.....	658	22,000	Total ...		613,000
140-160.....	410	30,000			

It is estimated that this earth can be excavated for 10 cents per cubic yard, making the cost of excavation \$61,300.

Two drifts will have to be removed from the Bogue Phalia, one at Helm and Northwestern Railway bridge and one at Lee's plantation. It is believed that they can both be removed for \$1,500. Two highway bridges will be required, one at Bussey's mill and one at the Gayoso tram. They will be 120 feet long and will cost approximately \$5 per foot, or \$600 per bridge. One railway bridge 140 feet long will be required and will cost approximately \$7.50 per foot, or \$1,050.

The two largest overflow channels should be closed by building substantial levees across them. These levees should have a top width of 8 feet, side slopes of 3 to 1, and are estimated to cost \$250 each.

The right of way along the river will have to be cleared so as to permit the proper disposal of the excavated material. It is estimated that this can be done for \$300 per mile; there are approximately 9 miles to be cleared, making a total cost of \$2,700.

Estimated cost of Bogue Phalia improvement.

613,000 cubic yards excavation, at 10 cents per cubic yard_	\$61,300
Removing drifts -----	1,500
Two highway bridges, at \$600 each -----	1,200
Clearing 9 miles of right of way at \$300 per mile -----	2,700
One railway bridge, at \$1,050 -----	1,050
Closing two overflow channels, at \$250 each -----	500
Total -----	68,250

DESCRIPTION OF BOGUE HASTY AND TRIBUTARIES.

Bogue Hasty drains an area of 46,250 acres east of the Bogue Phalia, beginning at a point about $1\frac{3}{4}$ miles south of the south line of Bolivar County and extending north 17 miles, with a width of 2 to $7\frac{1}{2}$ miles. It is formed by the junction of West Bogue Hasty and East Bogue Hasty in sec. 29, T. 21 N., R. 6 W. It has a well-defined channel throughout its entire course, with a top width between banks of 80 to 150 feet, a bottom width of 20 to 60 feet, and depths of 4 to 8 feet. The fall of the channel is approximately 0.8 foot per mile. It is in bad order, due largely to the timber along its banks being felled and the tops left in the bayou. Some cypress trees and brush grow in the channel, all of which should be removed. West Bogue Hasty leaves Kimball Lake in sec. 10, T. 22 N., R. 6 W., and runs southwest. It is dry in the summer, but when Kimball Lake is high acts as an overflow channel and has therefore kept in fair condition. It drains an area of 8,870 acres, most of which is in timber. The channel varies in width from 70 to 150 feet at the top, from 25 to 75 feet at the bottom, and is from 4 to 6 feet deep. East Bogue Hasty heads in sec. 31, T. 23 N., R. 6 W., and flows southwest to its junction with West Bogue Hasty. South of Skene the drainage area is heavily timbered, while to the north there are many clearings and some open woods. East Bogue Hasty drains 9,900 acres, and has one tributary, Icy Bayou, which drains 5,320 acres, making a total for both of 15,220 acres. East Bogue Hasty has a top width averaging 100 feet, and from 20 to 80 feet on the bottom, with a depth of from 2 to 7 feet. The channel has a slope of about 1 foot per mile. It is grown up with trees and is in bad order. Icy Bayou begins in sec. 1, T. 22 N., R. 6 W., and runs southwest to a junction with East Bogue Hasty

in sec. 28, T. 21 N., R. 6 W. Its drainage area of about 5,320 acres is about equally divided between heavy woods, open woods, and cleared land. The channel varies in top width from 60 to 120 feet and in bottom width from 20 to 50 feet. It has an average depth of 4 feet and a fall of approximately 1 foot per mile.

Pecan Bayou is the largest tributary to Bogue Hasty. It heads in sec. 30, T. 22 N., R. 6 W., and runs southwest to a junction with Bogue Hasty in sec. 33, T. 21 N., R. 6 W. It has a drainage area of 16,540 acres, about two-thirds of which is cleared land and the balance timber. It is a large bayou, the channel varying in width from 100 to 360 feet on top and from 30 to 150 feet on the bottom, and averaging between 4 and 5 feet deep. The fall is about 1 foot to the mile. The channel is badly grown up with trees and brush and is clogged with drift. Where it has been cleared of obstructions the beneficial results have been very marked.

PROPOSED IMPROVEMENT OF THE BOGUE HASTY AND TRIBUTARIES.

The improvements of the Bogue Hasty have been designed of sufficient capacity to remove three-fourths of an inch of water in twenty-four hours from the entire watershed of the stream, requiring a discharge of 1,458 cubic feet per second. From the junction of West Bogue Hasty and East Bogue Hasty to the outlet a channel with a 38-foot bottom, side slopes of 1 to 1, a fall of 1.05 feet per mile, and an average depth of 9.6 feet has been designed. This channel will give a discharge of 1,461 second-feet.

The following is a tabulated statement of the excavation required for the improvement of the channel:

Excavation required for Bogue Hasty.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
E 0-20 ...	4.6	14,500	G 80-100	5.0	15,800
E 20-40 ...	4.4	13,800	G 100-120	3.6	11,000
E 40-60 ...	4.4	13,800	G 120-140	2.0	6,000
E 60-80 ...	4.6	14,500	G 140-160	.0	0
E 80-100 ...	4.4	13,800	G 160-180	1.8	5,200
E 100-120 ...	4.3	13,500	G 180-200	3.3	10,100
E 120-145 ...	5.6	23,200	G 200-220	3.5	10,700
^a G 0-20 ...	7.3	24,500	G 220-228	3.5	4,300
G 20-40 ...	6.0	19,500			
G 40-60 ...	5.0	15,900	Total ...		248,900
G 60-80 ...	5.8	18,800			

$$^a E 145 + 47 = G 0.$$

Estimated cost of improving Bogue Hasty.

248,900 cubic yards excavated, at 10 cents per cubic yard	\$24, 890
Four highway bridges, at \$350 each	1, 400
Clearing 7 miles of right of way, at \$200 per mile	1, 400
Total	27, 690

WEST BOGUE HASTY.

Plans for the improvement of the West Bogue Hasty provide for a ditch of sufficient capacity to remove three-fourths of an inch in depth of water in twenty-four hours from the entire watershed of 8,870 acres, or 280 cubic feet per second. A ditch with a 10-foot base, gradually decreasing to 4 feet, with a fall of 1.06 feet per mile and having an 8-foot berm is necessary.

The following is a tabulated statement of the required excavation:

Excavation required for West Bogue Hasty.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
228-240.....	3.5	2,100	420-440.....	1.2	1,000
240-260.....	3.3	3,300	440-460.....	1.1	900
260-280.....	3.5	3,500	460-480.....	.8	700
280-300.....	3.3	3,300	480-500.....	.5	400
300-320.....	3.0	3,900	500-520.....	.4	300
320-332.....	1.4	700	520-540.....	.4	300
332-352.....	.0	0	540-560.....	.3	200
352-360.....	1.0	300	560-580.....	.2	200
360-380.....	2.2	2,000	580-600.....	.1	100
380-400.....	1.4	1,800	Total.....		25, 200
400-420.....	1.2	1,200			

The levee should have a top width of 8 feet, side slopes of 3 to 1, and will be about 12 feet high and 150 feet long. It is estimated to cost \$250.

Estimated cost of improving West Bogue Hasty.

25,200 cubic yards excavation, at 15 cents per cubic yard	\$3, 780
Three highway bridges, at \$150 each	450
Clearing 7 miles of right of way, at \$200 per mile	1, 400
Clearing 5 miles of channel	1, 000
Closing channel at Kimball Lake	250
Total	6, 880

EAST BOGUE HASTY.

The improvement of East Bogue Hasty has been planned to provide sufficient capacity for the removal of three-fourths of an inch of

water in twenty-four hours from the entire watershed of 15,200 acres, requiring a total discharge of 480 cubic feet per second. A channel having a bottom width of 21 feet, side slopes of 1 to 1, and a depth of 7 feet from the top of the bank is needed. This size channel will be required from the outlet to its junction with Icy Bayou, a distance of 5,000 feet. From this point, for 287 stations upstream, the ditch has a 12-foot base, and for the remainder of the distance to the upper end, a 10-foot base. The fall in the bottom of the channel will be 1.28 feet per mile, and the depth 4 to 6 feet from the top of the bank to the bottom of the proposed ditch. The following is a tabulated statement of the excavation required to complete the work:

Excavation required for East Bogue Hasty.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
0-20.....	4.3	3,900	400-420.....	1.6	1,300
20-40.....	4.0	3,500	420-440.....	2.6	2,000
40-60.....	4.0	3,500	440-460.....	2.8	2,200
60-80.....	4.0	3,500	460-480.....	2.8	2,200
80-100.....	3.8	3,300	480-500.....	2.8	2,200
100-120.....	3.4	2,900	500-520.....	3.0	2,400
120-140.....	3.0	2,400	520-540.....	3.2	2,640
140-160.....	2.7	2,150	540-560.....	3.5	3,000
160-180.....	2.5	1,950	560-580.....	3.7	3,200
180-200.....	2.4	1,850	580-600.....	3.8	3,300
200-220.....	2.4	1,850	600-620.....	4.2	3,800
220-240.....	2.4	1,850	620-640.....	4.4	4,000
240-260.....	2.4	1,850	640-660.....	4.4	4,000
260-280.....	2.2	1,650	660-680.....	4.6	4,250
280-300.....	2.0	1,450	680-700.....	4.9	4,650
300-320.....	1.9	1,350	700-720.....	5.0	4,800
320-340.....	1.9	1,350	720-727.....	5.0	1,960
340-360.....	1.9	1,350			
360-380.....	1.5	1,050	Total		95,400
380-400.....	1.2	800			

Estimated cost of improving East Bogue Hasty.

95,400 cubic yards of excavation, at 15 cents per cubic yard.....	\$14,310
Eight highway bridges (208 running feet, at \$5 per foot).....	1,040
One 50-foot railroad bridge, at \$7.50 per foot.....	375
Clearing 14 miles of right of way, at \$200 per mile.....	2,800
Total.....	18,525

ICY BAYOU.

The improvement of Icy Bayou is planned to provide sufficient capacity to remove three-fourths of an inch of water in twenty-four hours from the entire watershed of 5,320 acres, or a total of 170 cubic feet per second. A ditch with a 10-foot bottom, side slopes of 1 to 1, and depth from 4 to 6 feet, and a fall of 1.06 feet per mile is recom-

mended. The following is a tabulated statement of the amount of excavation required to complete this work:

Excavation required for Icy Bayou.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
0-20.....	3.0	2,400	340-360.....	2.4	1,850
20-40.....	2.6	2,000	360-380.....	2.2	1,670
40-60.....	2.7	2,150	380-400.....	2.0	1,480
60-80.....	3.0	2,400	400-420.....	1.8	1,300
80-100.....	3.2	2,700	420-440.....	2.0	1,480
100-120.....	3.3	2,800	440-460.....	2.4	1,850
120-140.....	3.2	2,700	460-480.....	2.2	1,670
140-160.....	3.1	2,550	480-500.....	2.0	1,480
160-180.....	2.7	2,150	500-520.....	2.3	1,760
180-200.....	2.7	2,150	520-540.....	2.8	2,200
200-220.....	2.5	1,950	540-560.....	3.5	3,000
220-240.....	2.4	1,850	560-580.....	4.2	3,800
240-260.....	2.4	1,850	580-600.....	4.6	4,500
260-280.....	2.4	1,850	600-620.....	4.9	4,650
280-300.....	2.4	1,850	620-640.....	5.0	2,800
300-320.....	2.4	1,850			
320-340.....	2.4	1,850	Total		72,520

Estimated cost of Icy Bayou improvement.

72,520 cubic yards of excavation, at 15 cents per cubic yard.....	\$10, 878
Seven highway bridges (184 feet, at \$5 per foot).....	920
One railroad bridge (50 feet, at \$7.50 per foot).....	375
Clearing 12 miles of right of way, at \$200 per mile.....	2,400
Total.....	14,573

PECAN BAYOU.

Pecan Bayou, which receives the run-off from 16,540 acres, has the largest drainage area of any of the bayous that unite to form the Bogue Hasty. It varies in width from 125 to 300 feet at the top and from 40 to 100 feet at the bottom, and has an average depth of 4 feet. The slope of the bottom is quite uniform, varying from 0.5 to 1 foot per mile. The channel has a carrying capacity large enough to remove three-fourths of an inch of water from its watershed in twenty-four hours, or 515 cubic feet per second. The calculated carrying capacity of the channel with flattest slope and small section is given below, computed by formula previously mentioned.

Fall = 0.5 foot per mile.

Area of channel, 370 square feet.

Wetted perimeter, 145 feet.

V = 1.4 feet per second.

Q = 518 cubic feet per second.

Capacity required, 515 cubic feet per second.

The only improvement that is necessary in Pecan Bayou, therefore, is to clear its channel so that it will have an unobstructed width of 100 feet. From this section all trees, stumps, brush, and drift should be removed. Ten miles of this channel will require to be

cleared, at an estimated cost of \$300 per mile, or a total of \$3,000. No new bridges will be required. To get the full benefit of the cleared channel, the Bogue Hasty and Bogue Phalia should be improved, or backwater from these channels will reduce the discharge from Pecan Bayou.

Estimated cost of clearing Pecan Bayou: Clearing 10 miles, at \$300 per mile, \$3,000.

SNAKE CREEK AND TRIBUTARIES.

Snake Creek drains about 58,900 acres of land west of the Yazoo and Mississippi Valley Railroad, east of the Bogue Phalia and north of the Bogue Hasty. From its source in Holmes Lake it flows south-east to sec. 35, T. 23 N., R. 6 W. Snake Creek has a large channel with running water and in places broadens out to form lakes. An examination was made to determine the feasibility of shortening the present channel by means of cut-offs in secs. 4 and 9, T. 22 N., R. 6 W., and in sec. 19, T. 22 N., R. 6 W., and sec. 24, T. 22 N., R. 7 W., but it was found that cleaning out the old channel would be cheaper. Bradford Bayou and Little Bradford Bayou are two small bayous discharging into Snake Creek. Holmes Lake is a long, shallow, horseshoe-shaped body of water. The territory drained by Snake Creek is approximately one-third cleared and the balance is timbered lands.

The improvements planned for Snake Creek are to begin in Holmes Lake at a point near the section line between secs. 1 and 12, T. 24 N., R. 6 W., and follow the lowest part of Holmes Lake to Porter Lake. It is proposed to excavate this channel to a width of 10 feet on the bottom, having side slopes of 1 to 1, depths from 1 to 5 feet below the present bed of the stream, and a fall of 0.53 foot per mile.

HOLMES LAKE.

The following is a tabulated statement of excavations required through Holmes Lake:

Excavation required for Holmes Lake.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
0-20.....	1.0	800	240-260.....	4.3	4,600
20-40.....	2.5	2,300	260-280.....	4.5	4,800
40-60.....	2.7	2,500	280-300.....	4.6	5,000
60-80.....	2.4	2,200	300-320.....	4.6	5,000
80-100.....	2.6	2,400	320-340.....	4.4	4,700
100-120.....	3.0	2,900	340-360.....	4.1	4,300
120-140.....	3.0	2,900	360-380.....	4.0	4,200
140-160.....	3.2	3,100	380-400.....	4.2	4,400
160-180.....	3.5	3,500	400-420.....	4.2	4,400
180-200.....	3.8	2,900	420-440.....	4.2	4,400
200-220.....	3.6	3,700			
220-240.....	3.6	3,700			
			Total ..		79,700

This part of the work will require the excavation of 79,700 cubic yards of earth, at an estimated price of 12 cents per cubic yard, or \$9,564.

Through Porter Lake no work will be required. Beginning at the foot of this lake, it is proposed to construct a channel about $2\frac{1}{2}$ miles long, with a bottom width of 14 feet, side slopes of 1 to 1, and a fall of 1.06 feet per mile.

Estimated cost of Snake Creek improvement.

79,700 cubic yards excavation, Holmes Lake, at 12 cents per cubic yard-----	\$9, 564
Six highway bridges, at \$120 each-----	720
Clearing 8.4 miles of right of way, at \$200 per mile-----	1, 680
39,000 cubic yards excavation below Porter Lake, at 12 cents per cubic yard-----	4, 680
50 feet of highway bridges, at \$5 per foot-----	250
Clearing $2\frac{1}{2}$ miles of right of way-----	500
Clearing 3 miles of channel above Sixmile Lake, at \$500 per mile-----	1, 500
Improving Sixmile Lake, $3\frac{1}{2}$ miles, at \$100 per mile-----	350
Improving 3 miles of channel from foot of Sixmile Lake to Kimball Lake, at \$1,000 per mile-----	3, 000
Improving 7 miles of channel below Kimball Lake, at \$1,500 per mile-----	10, 500
One 80-foot railroad bridge, at \$7.50 per foot-----	600
Total-----	33, 344

An examination was made to determine the feasibility of diverting the water of Holmes Lake from Snake Creek to some other channel. From a study of the available maps it became apparent that there are two possible cut-offs, one from a point about 1 mile north of Shelby northeast to a ravine running into the Hushpuckana River, the other from a point on Holmes Lake south of Shelby, southeast to the Yazoo and Mississippi Valley Railroad, and parallel to the railroad to Big Mound Bayou. After the survey it was found that to make the first-named cut-off would require 140,000 cubic yards of excavation at an estimated cost of 10 cents per cubic yard, or a total cost of \$14,000. In addition about 20 acres of right of way would cost \$600, and one railroad bridge estimated to cost \$4,000. Clearing of $1\frac{1}{2}$ miles of right of way, \$300.

The cut-off to Big Mound Bayou would require the excavation of 160,000 cubic yards of earth, which, at an estimated cost of 10 cents per yard, would amount to \$16,000; about 30 acres of right of way, to cost \$900, and 2 miles of clearing to cost \$200.

To take the water by the present outlet through Snake Creek would require, as stated previously, 81,000 cubic yards of excavation at an estimated cost of 12 cents per yard, or \$9,720.

The following table gives the comparative costs of the different methods of caring for the water of Holmes Lake:

Comparative cost of different methods of caring for water of Holmes Lake.

Hushpuckana cut-off-----	\$18, 900
Big Mound cut-off-----	17, 100
Present channel-----	9, 720
Saving by using present channel-----	7, 380

SANDY SLOUGH.

Sandy Slough is a small tributary entering Snake Creek in sec. 30, T. 22 N., R. 6 W. It has a drainage area of 2,500 acres, and is of importance chiefly because in times of high water in the Bogue Phalia the water of Snake Creek overflows into Sandy Slough and thence through Grassy Lake and Gallagher Level into West Bogue Hasty. This flow from the Bogue Phalia should be prevented. This can be accomplished in two ways: (1) By placing a dam across Sandy Slough, southerly through Gallagher Level and Grassy Lake to the West Bogue Hasty, necessitating the construction of about 4 miles of ditch, and (2) by placing a sluice gate in Sandy Slough where it enters Snake Creek, to be used in preventing the flow of water from Snake Creek into Sandy Slough during high water while allowing water to pass from Sandy Slough to Snake Creek at other times. The most permanent structure would be a line of 3-foot sewer pipe in the bottom of Sandy Slough, laid on a grade of 2 feet per 100, with each end set in a brick retaining wall, and with a valve placed over the end to prevent the water from flowing into the slough in time of high water. A 3-foot pipe will be ample to remove the water from the drainage area. A brick retaining wall should be built at each end of the pipe, and the ends of the wall should be rounded off. The bank over the pipe should have a top width of 8 feet and side slopes of 3 to 1, and should be approximately 16 feet high.

The estimated cost of pipe and sluice gate complete is given below:

Estimated cost of pipe and sluice gate, Sandy Slough.

100 feet 3-foot pipe, at \$3 per foot-----	\$300
7,000 brick, at \$12 per thousand-----	84
10 barrels cement, at \$5 per barrel-----	50
Hauling material-----	250
Excavating 2,000 cubic yards earth, at 10 cents per cubic yard-----	200
Sluice gate-----	25
Total -----	909

To construct the 4 miles of ditch through Grassy Lake and Gallagher Level will cost approximately \$1,200 per mile, and the dam for closing the slough will cost \$200, making the total cost of this improvement \$5,000, as against \$909 for the sluice gate and pipe.

Bradford Bayou, with a drainage area of approximately 11,500 acres, heads in a large cypress brake in sec. 36, T. 24 N., R. 6 W., and flows southwest to join Snake Creek in sec. 27, T. 23 N., R. 6 W. Its one large tributary, Little Bradford Bayou, heads near the southwest corner of sec. 26, T. 24 N., R. 6 W., and extending southerly joins Bradford Bayou in sec. 27, T. 23 N., R. 6 W.

It is planned to improve Bradford Bayou so that it will have sufficient capacity to remove the water from the entire watershed in twenty-four hours, or 360 cubic feet per second. A channel with a 10-foot bottom, side slopes of 1 to 1, and an effective depth of 10 feet at the lower end will be more than sufficient.

The following is a statement of the excavation required to make the improvement:

Excavation required for Bradford Bayou.

Station.	Cut.	Excavation.	Station	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
0-20.....	0.0	0	260-280.....	0.6	500
20-40.....	.5	400	280-300.....	.9	700
40-60.....	1.1	900	300-320.....	1.1	900
60-80.....	1.4	1,200	320-340.....	1.7	1,500
80-100.....	1.4	1,200	340-360.....	1.9	1,700
100-120.....	1.4	1,200	360-380.....	2.0	1,800
120-140.....	1.4	1,200	380-400.....	3.0	2,900
140-160.....	1.0	800	400-420.....	3.0	2,900
160-180.....	.4	300	420-440.....	3.0	2,900
180-200.....	.0	0	440-450.....	3.5	1,500
200-220.....	.8	700			
220-240.....	1.0	800	Total.....		26,500
240-260.....	.6	500			

Estimated cost of Bradford Bayou improvement.

26,500 cubic yards excavation, at 15 cents per cubic yard.....	\$3, 975
Three 50-foot highway bridges, at \$250 each.....	750
Clearing 8.5 miles of right of way.....	1, 700
Total.....	6, 425

LITTLE BRADFORD BAYOU.

Little Bradford Bayou, the main tributary of Bradford Bayou, if its channel is cleared out and a good outlet provided, will be amply large to drain the territory tributary to it. It is recommended that a 75-foot channel be cleared of all obstruction for a distance of $4\frac{1}{2}$ miles, which probably will cost \$900.

BIG MOUND BAYOU.

Big Mound Bayou drains nearly all that part of Bolivar County that lies east of the Yazoo and Mississippi Valley Railroad, north of a line drawn east from Merigold, Miss., and south of the Hush-puckana River, an area of about 30,380 acres. It receives two large tributaries, Little Mound Bayou, having a drainage area of 11,200 acres, and Beaver Bayou, having a drainage area of 10,140 acres.

Big Mound Bayou heads in the large cypress brake known as Barrows Lake in secs. 20, 21, and 22, T. 24 N., R. 5 W., and runs southwest to the town of Mound Bayou. From here it runs southeast to a point about $1\frac{1}{4}$ miles east of Merigold, Miss., and thence almost due east to the Sunflower River. The upper part of the stream is shallow and in bad order; the lower 4 miles is deep and in good order.

Little Mound Bayou heads in secs. 9 and 10, T. 24 N., R. 5 W., and flows south to a junction with Big Mound Bayou in sec. 10, T. 23 N., R. 5 W. It flows through part of its course in Sunflower County, and the drainage area tributary to it is situated in both Bolivar and Sunflower counties.

PROPOSED IMPROVEMENT OF BIG MOUND BAYOU AND TRIBUTARIES.

It is proposed to construct a channel beginning at Barrows Lake, with 10-foot base, side slopes of 1 to 1, and a fall of 1.06 feet per mile. The depth of the channel will vary from 8 to 10 feet, measuring from the top of the bank.

The following is a tabulated statement of the excavation required to complete the channel:

Excavation required for Big Mound Bayou.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
200-220.....	0.6	500	400-420.....	3.9	4,000
220-240.....	1.2	1,000	420-440.....	3.3	3,300
240-260.....	1.7	1,500	440-460.....	2.3	2,100
260-280.....	2.2	2,000	460-480.....	1.3	1,100
280-300.....	2.6	2,400	480-500.....	1.5	1,300
300-320.....	3.1	3,000	500-520.....	1.6	1,400
320-340.....	3.3	3,300	520-540.....	2.1	1,900
340-360.....	3.4	3,400	540-550.....	3.0	1,500
360-380.....	3.3	3,300			
380-400.....	3.7	3,800	Total.....		40,800

Estimated cost of Big Mound Bayou improvement.

40,800 cubic yards of excavation, at 15 cents per cubic yard.....	\$6,120
Six highway bridges, at \$250 each (50-foot bridges).....	1,500
Clearing 9 miles of right of way, at \$200 per mile.....	1,800
Total.....	9,420

LITTLE MOUND BAYOU.

Little Mound Bayou has a large, deep channel that would easily drain the country tributary to it if it were in good order. It is recommended that a clear channel of 100 feet should be made by removing all trees, stumps, and drift. There will be 10 miles of this clearing, which will cost \$300 per mile, or \$3,000.

BEAVER BAYOU.

Beaver Bayou is large and deep. It is proposed to make a cut-off, beginning at the bayou just north of the south line of sec. 31, T. 24,
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R. 4 W., and running east about one-half mile to a deep ravine, which opens into the Sunflower River.

A channel, with 10-foot base, side slopes of 1 to 1, and a grade of 1 foot per mile is necessary.

A tabulated statement of excavation required is given below:

Excavation required for Beaver Bayou cut-off.

Station.	Cut.	Excavation.	Station.	Cut.	Excavation.
	<i>Feet.</i>	<i>Cubic yards.</i>		<i>Feet.</i>	<i>Cubic yards.</i>
340-354.....	3.0	400	420-440.....	4.0	1,800
354-360.....	15.0	6,600	440-460.....	5.0	2,900
360-380.....	16.0	24,800			
380-400.....	4.0	1,800	Total ..		40,100
400-420.....	4.0	1,800			

Estimated cost of Beaver Bayou cut-off.

40,100 cubic yards of excavation, at 15 cents per cubic yard.....	\$6,015
Two 50-foot highway bridges, at \$250 each.....	500
Clearing 3 miles of right of way, at \$200 per mile.....	600
Total	<u>7,115</u>

If the cut-off is made, no work will be required on Beaver Bayou above that point. If it is not made, then Beaver Bayou will have to be enlarged from station 160 to Goose Lake, a distance of 6 miles, and the channel below will have to be cleared for 3 miles. This cost is estimated at \$8,000. All the work on the cut-off and most of that on Beaver Bayou is in Sunflower County. The cut-off would be easier to maintain in good order than Beaver Bayou, being but about one-third as long.

SUMMARY OF COST OF IMPROVEMENTS, ACREAGE BENEFITED, AND AVERAGE COST PER ACRE.

Bogue Phalia.....	\$68,250.00
Adding 10 per cent for contingent expenses.....	6,825.00
Total cost.....	<u>75,075.00</u>
Deducting 5 per cent for road and railroad assessment.....	3,753.75
Total amount to be assessed to drainage area....	<u><u>71,321.25</u></u>
Acres benefited, 110,000. Average cost per acre, 65 cents.	
Bogue Hasty	27,690.00
Adding 10 per cent for contingent expenses.....	2,769.00
Total cost	<u>30,459.00</u>
Deducting 5 per cent for road and railroad assessment.....	1,522.95
Total amount to be assessed to drainage area....	<u><u>28,936.05</u></u>
Acres benefited, 50,950. Average cost per acre, 57 cents.	

West Bogue Hasty-----	\$6, 880. 00
Adding 10 per cent for contingent expenses-----	688. 00

Total cost -----	7, 568. 00
Deducting 5 per cent for road and railroad assessment--	378. 40

Total amount to be assessed to drainage area--	7, 189. 60
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Acres benefited, 8,870. Average cost per acre, 81 cents.

East Bogue Hasty -----	18, 525. 00
Adding 10 per cent for contingent expenses -----	1, 852. 50

Total cost -----	20, 377. 50
Deducting 5 per cent for road and railroad assessment--	1, 018. 88

Total amount to be assessed to drainage area--	19, 358. 62
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Acres benefited, 9,900. Average cost per acre, \$1.95.

Icy Bayou-----	14, 573. 00
Adding 10 per cent for contingent expenses-----	1, 457. 30

Total cost-----	16, 030. 30
Deducting 5 per cent for road and railroad assessment--	801. 52

Total amount to be assessed to drainage area--	15, 228. 78
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Acres benefited, 5,320. Average cost per acre, \$2.86.

Pecan Bayou-----	3, 000. 00
Adding 10 per cent for contingent expenses-----	300. 00

Total cost-----	3, 300. 00
Deducting 5 per cent for road and railroad assessment--	165. 00

Total amount to be assessed to drainage area--	3, 135. 00
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Acres benefited, 16,540. Average cost per acre, 19 cents.

Snake Creek-----	41, 578. 00
Adding 10 per cent for contingent expenses-----	4, 157. 80

Total cost-----	45, 735. 80
Deducting 5 per cent for road and railroad assessment--	2, 286. 79

Total amount to be assessed to drainage area--	43, 449. 01
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Acres benefited, 58,900. Average cost per acre, 73 cents.

Big Mound Bayou-----	9, 420. 00
Adding 10 per cent for contingent expenses-----	942. 00

Total cost-----	10, 362. 00
Deducting 5 per cent for road and railroad assessment--	518. 00

Total amount to be assessed to drainage area--	9, 844. 00
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Acres benefited, 9,040. Average cost per acre, \$1.09.

Little Mound Bayou-----	\$3,000.00
Adding 10 per cent for contingent expenses-----	300.00
Total cost-----	3,300.00
Deducting 5 per cent for road and railroad assessment--	165.00
Total amount to be assessed to drainage area--	<u>3,135.00</u>

Acres benefited, 11,200. Average cost per acre, 28 cents.

Beaver Bayou-----	7,115.00
Adding 10 per cent for contingent expenses-----	711.50
Total cost-----	7,826.50
Deducting 5 per cent for road and railroad assessment--	391.33
Total amount to be assessed to drainage area--	<u>7,435.17</u>

Acres benefited, 10,140. Average cost per acre, 73 cents.

Total cost of improvements in all districts----- 220,033.00

These figures represent the average cost per acre in each district. When the assessments are made the cost price will fluctuate from less than \$1 to \$4 or \$5 per acre, in some instances, depending upon the lay and condition of the land and its proximity to the improvement. The low, wet lands which are unproductive should pay the highest rate per acre. In many States the laws govern this matter to some extent, but to work out a plan of assessment which is just to all concerned, and legal in every respect, is one of the most important features to be looked after in drainage undertakings of this class. A tax of 5 per cent is here assumed to be paid by the railroads, and out of the public-road fund, and 10 per cent added for contingent expenses, to cover the legal expenses, engineering, printing, fees to officers, and other incidental expenses. In many cases these expenses exceed 15 per cent, especially when there is organized opposition to the drainage plan. The details of assessment will be worked out by those interested.

The plan outlined herein is sufficient to provide for good drainage outlets for lands in the district under examination. The interior drainage of the lands between the bayous will follow the construction of the main ditches and will be done by the landowners themselves. Were it not for the bayous, in their present locations, a system of parallel ditches would have to be constructed at intervals of a mile or more apart. As it is, nature has provided a system which, if once enlarged, will furnish relief from the wet and swampy conditions heretofore existing. These benefits to the land are so great, compared to the cost of this work, that the improvements should begin as soon as possible; and there is no owner of land in this local-

ity who can not well afford to pay the tax for drainage as herein recommended.

BENEFICIAL RESULTS.

At the present time there is a large amount of land lying idle in the district. It is not farmed on account of the danger of losing crops because of the wetness of the soil. There was estimated to be 4,000 acres of land in the district last year in this condition. There is also a class of lands which will usually produce a crop, but on which the yield is greatly decreased during wet years. Practically all the lands in the district, about 120,000 acres, will be either wholly reclaimed or greatly benefited. Thorough drainage would undoubtedly increase the rental value of this land \$1 per acre per annum. By the expenditure of \$220,000 in ditching the land values can be doubled or tripled in many cases, and the increase in value begins as soon as the improvements are under way.

Another advantage of the improvement will be in the ability to construct good roads, as good road ditches are a primary requisite in road building. Under existing conditions it is almost impossible to construct a road that can be maintained in passable condition during the wet season, which is a serious drawback in the hauling of crops to market.

With the construction of the ditches and the drainage of the low, wet lands, there will be a decided improvement in the health conditions of the community. This has been found to be true elsewhere, and undoubtedly will be in this district.

METHODS AND CONCLUSIONS.

The area under examination in Bolivar County is divided into two districts, one draining into the Bogue Phalia and the other into the Sunflower River, and they should be so organized and the work let in separate contracts. In the Bogue Hasty district the improvements should be made in the following order: First, Bogue Phalia; second, Bogue Hasty; third, tributaries of Bogue Hasty, either separately or together as necessity demands. Snake Creek and tributaries can be improved at any time, either before or after the Bogue Phalia work is done, but better afterwards. When the main outlet channels are completed it is sometimes better to complete the smaller tributaries separately, provided the work is heavy enough to secure low prices in dredging. The work should be done with a floating dredge, it being almost impossible to dig ditches with teams and scrapers and compete in price. The usual method of doing this work is by the letting of a contract to a responsible party, under the supervision of the drainage commissioners. In any case, the strict

adherence to all drainage laws of the State is necessary, both as to the manner of advertising and letting the contract and the methods of making assessments.

LOCATION, DESCRIPTION, AND ELEVATION OF BENCH MARKS.

Location.	Description.	Elevation above sea level.
<i>Permanent bench marks.</i>		
Stoneville, Miss	United States permanent bench mark in orchard belonging to J. C. Greenlay.	<i>Feet.</i> 142.17
Shaw, Miss	Lee's plantation on Bogue Phalia, in front of house.	149.62
Skene, Miss	In railroad section foreman's yard, 20 feet west of southwest corner of house.	151.34
Cleveland, Miss	In court-house yard, southwest corner.	157.68
Shelby, Miss	In yard, near southeast pier of water tank	172.79
<i>Temporary bench marks.</i>		
Bogue Phalia	On letter "N" of word "Mansfield," on top of pump east side of Helm and Northwestern Railway, south of Washington-Bolivar County line.	144.81
Do	Nail north side 10-inch elm, southwest corner of bridge near Busey's store.	143.97
Do	Spike in 24-inch sweet gum, east side Helm and Northwestern Railway, at entrance to Gayoso tram.	145.04
East Bogue Hasty	Cut in cap on top of pile bent, south side bridge over East Bogue Hasty, line between secs. 21 and 28, T. 21 N., R. 6 W.	145.84
Do	Cone-shaped cut, root 36-inch oak, north side of bridge, on line between secs. 10 and 15, T. 21 N., R. 6 W.	146.69
Do	Spike in northwest corner of northwest corner post of bridge, on line between secs. 14 and 23, T. 22 N., R. 6 W.	155.08
Pecan Bayou	Spike in 14-inch hackberry, station 198.	143.91
Do	Spike in northwest corner plank at end of railing to bridge, between secs. 34 and 35, T. 21 N., R. 6 W.	146.61
Do	Top of iron pipe, corner of road near line between secs. 6 and 7, T. 21 N., R. 5 W.	147.85
Icy Bayou	Spike in root 30-inch white oak, south of bridge, on line between townships 21 and 22, R. 6 W.	148.16
Do	Bolt in root 36-inch gum, east end bridge, between secs. 14 and 23, T. 22 N., R. 6 W.	153.64
Snake Creek	Spike on west side southwest corner post of bridge over Snake Creek, on road along Bogue Phalia.	155.99
Do	Cone-shaped cut in 24-inch tree in yard of Mount Olive Missionary Baptist Church, old building.	165.08
Do	Spike in root of 24-inch black gum, southeast corner bridge over Sixmile Lake near corner secs. 9, 10, 15, and 16.	165.88
Bogue Hasty	Spike in east side of stump, at southwest corner bridge over Bogue Hasty, near Gayoso mill.	143.22
Do	Spike in north side 36-inch gum, at entrance to road leading to Lee's plantation.	148.57
Do	Spike in 14-inch hackberry, near station 198 + 01.	143.91
Do	Nail in cypress snag, near station 227 + 76.	143.11
West Bogue Hasty	Spike in northeast side 48-inch white oak, 30 feet south of bridge on line between townships 21 and 22, R. 6 W.	146.94
Do	Spike in north side northeast post of bridge on Cleveland road, near corner secs. 15, 16, 21, and 22.	153.16
Do	Spike in root of 40-inch water oak, south bank, where West Bogue Hasty leaves Kimball Lake.	159.09
Holmes Lake	Spike in root of 36-inch elm in front of Shelby residence, near line between secs. 14 and 15, T. 24 N., R. 6 W.	172.26
Do	Spike in root of 20-inch elm opposite station 431 and 150 feet east of church, north side of road.	170.04
Big Mound Bayou	Top of bolt, sixth pier cap from northeast end west side Yazoo and Mississippi Valley Railroad bridge, L. 101-96, bench mark cut in stringer.	168.47
Do	Top of bolt in pier cap, south end, east side Yazoo and Mississippi Valley Railroad bridge, L. 104-96.	165.33
Little Mound Bayou ..	Spike in root 40-inch red oak, west bank of bayou, on line between secs. 23 and 26, 24, 25.	166.15
Do	Spike in south side of post, west bank of bayou, on line between secs. 11 and 14, 24, 25.	171.05
Beaver Bayou	Spike in root, south side 26-inch red oak, west bank of bayou, tree on line between townships 23, 24, R. 5 W.	166.22
Do	Spike in 18-inch elm, north side fence, west side of bayou, at foot of Goose Lake.	158.93

